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# Stratigraphy of the Central Camplain Valley

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# Trip C - Stratigraphy of the Central Champlain Valley

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The purpose of the trip is to show some of the typical exposures of the Ordovician and Cambrian rocks which outcrop in the Central Champlain Valley. Two stops will be made for fossil-collecting.

Structurally the area is relatively simple; gentle tilting predominates. However, along the Champlain Thrust and the subsidiary thrusts accompanying it, the structures become more confused. There are overturned, isoclinal folds present in the upper thrust plates, and strong evidence exists to support the concept of post-thrusting cross-faulting. It is not unlikely that evidence for several deformations exists in the faulting if it can be unraveled. On the south slope of Buck Mountain (northeast of mile 67.2) the fault plane of a reverse fault cutting the Champlain Thrust can be seen. North of Vergennes and in Charlotte the presence of transverse faults can be shown. Some of the cross-faulting will be demonstrated in an approximate fashion during the trip. Section AA', Plate C-1 illustrates diagrammatically some of the structural relationships. It should be pointed out that the plane of the fault next to the Champlain Thrust can be seen on Buck Mountain. The stratigraphic relations indicate that the easternmost Orwell-Crown Point-Bridport sequence is the eastern limb of an overturned syncline; however, there is some evidence to suggest that each outcrop belt represents a thrust fault and that the beds have been shoved out in an order reverse to their normal sequence, retaining their topside uppermost. High angle faults which have downdropped the older beds of the overthrust masses against the younger beds of the lower plate exist. One such fault is exposed at the quarry south of Vergennes.

The sequence is of Ordovician age with the exception of the Upper Cambrian Ticonderoga formation, although the area is bordered on the east by the Lower Cambrian Monkton formation lying above the Champlain Thrust.

No attempt is made to explain the regional correlations. Papers in the selected references discuss this aspect, although the author does not necessarily agree with all the conclusions voiced in them. The following table gives a brief resume of the stratigraphy.

## Ordovician - Champlainian

### Mohawkian Stage

Iberville shale: Black, brittle, non-calcareous, thin-bedded, thin-cleaving, with occasional beds and laminae or orange-weathering dolomitic siltstones and silty dolostones; generally unfossiliferous, although graptolites have been found. The formation is well exposed on Shelburne Point near Burlington, and it appears again south of the south end of Snake Mountain. Thickness is probably in excess of 1000' but no direct measurements have been made.

Stony Point shale: Black, caccareous, splintery shale with occasional beds of olive-gray weathering finely crystalline limestones and dolostones. Some black non-calcareous shale, and a few orange-weathering dolostones and silty dolostones. Within the area of the field trip the dolostones and limestones are rare. The formation grades upward into Iberville through a transition zone of interbedded non-calcareous and calcareous shale with occasional orange-weathering dolomitic beds. Graptolites, occasional brachiopods, and the trilobite Triarthus beckii (Green) are common in places. The formation in the past has been grouped with the Iberville and both correlated with the Canajoharie shale of the Mohawk Valley. The Hortonville east of the thrust belt may correlate with the combined Iberville-Stony Point[1]. Thickness is estimated to be in excess of 500'.

Glens Falls limestone: Highly fossiliferous black argillaceous limestone with thinner shale beds between the 6 to 12 inch beds of limestone. Where the formation is relatively undeformed, it can be broken down into two members: the lower, Larrabee member, and the upper, Shoreham member. Characteristic fossils include: Cryptolithus, Flexicalymene, Isotelus, a variety of ramose bryozoans, Prasopora, Rafinesquina, Reuschella, Sowerbyella, Resserella, Dinorthis, Strophomena, Trematis, Zygospira, Lingula, Doleroides, and Conularia. The layers of fossil fragments are useful in distinguishing between cleavage and bedding.

The top of the formation is gradational into the overlaying Stony Point shale; the transition zone probably correlates with the Cumberland Head formation to the north. 350-400' thick.

Orwell limestone: Black massive beds of sublithographic and lithographic limestone with layers of brachiopod and gastropod fragments common. Characterized by a rectangular scoring-pattern in most exposures and by masses of blue-black chert as well as the dolomitized brachiopod and gastropod fragments. Probably includes both "Lowville" and Isle la Motte limestones auctores. Averages about 40', but in places it attains almost 100'.

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[1] Editor's note: See discussions on the "Hortonville formation" in section of Trip A, however.

Chazyan Stage

Chazy Group. The group correlates with the Middlebury limestone east of the thrust.

Valcour formation: Variable in composition, both vertically and laterally; dolomitic and silty limestones and calcitic dolostones. Many of the limestones are very finely crystalline to sublithographic; others are medium and coarse grained. Pale orangish brown weathering dolostones are common. The beds are notably sandy in places; in other areas the limestones resemble closely the overlying beds of the Orwell while in still other localities the formation is composed of coarse- and medium-grained fossil-fragmental limestones. The formation seems restricted to the western one-half of the area, being replaced in the east by the Crown Point-type lithology. The formation is gradational into the overlying limestones; with few exceptions the lower contact is easily recognizable, although it too is of a gradational nature. Varies from ±20 feet east of the mouth of Otter Creek, north of Vergennes, to possibly as much as 200 feet near Crown Point.

Crown Point limestone: Bluish gray weathering, bluish gray, generally massively bedded limestone; sublithographic to coarse-grained fossil-fragmental limestones. Characterized by black and buff dolomitic silt and silty dolomite partings and laminae which cause a nodular-weathering habit where closely spaced. Average thickness is between 150 and 200 feet. Although not restricted to the formation, the large low-spired gastropod Maclurites magna Leseur characterizes the formation, hence the synonym for it, "Maclurites beds."

Day Point formation: Chiefly a limestone-shale sequence with important quantities of finely crystalline silty dolostones and dolomitic siltstones which are useful in recognizing the formation where the limestone beds closely resemble the overlying Crown Point. Fossil-fragmental limestones are the chief component of the upper one-third of the formation. Olive-colored, non-calcareous shale is an important component in the western exposures. Tough quartz sandstones are found in the formation along the lake. Eastward the formation is a sequence of orange-weathering dolomitic siltstones and silty very finely-crystalline dolostones with interbedded thin-bedded limestones in places. The formation averages 40 to 50 feet thick, but is as much as 150 feet near Long Point, west of North Ferrisburg, and as little as 20 feet near the Champlain Thrust. The formation seems to be consistently present between the Crown Point and the underlying Bridport, a fact which is important in interpreting the structural relations near the thrusts.

A sandy zone which may correspond to the Day Point has been noted by the author at the base of the Middlebury formation in Cornwall; Oxley and Kay (1959) report a sandy zone at its base in Weybridge.

Wherever the contact between the Day Point and the underlying Bridport is exposed, the two formations appear conformable. However, some authors indicate the presence of a disconformity between the two formations, partly on the supposed absence of Day Point in exposures south of the field trip area.

? Disconformity ?

Ordovician - Canadian

----- Stage

Beekmantown Group

Bridport dolostone: The formation is light buff to yellowish orange and light bluish gray weathering, moderately to heavily scored, very finely crystalline dolostone with occasional light bluish gray sub-lithographic, sheared-appearing limestones and thin beds of non-calcareous shale. Generally in beds 1 to 2 feet thick. Thickness about 450' to 500'. This formation correlates with the Beldens formation east of the thrust.

Cassin limestone: The formation can be divided into two units in the Central Champlain Valley; a lower sandy limestone sequence which characteristically weather dark gray with rust-colored raised ridges of more sandy material and an upper unit which consists of bluish weathering, dark gray sublithographic and lithographic limestones, some of which have significant amounts of black silt partings. These limestones may be easily mistaken for Crown Point beds. The bulk of the Fort Cassin fauna came from the upper unit. Only the upper unit is exposed within the area of the field trip (mile 58.4). East of the thrust belt and south of the Central Champlain Valley both limestones and dolostones underlie the Cassin formation; within the Central Champlain Valley the immediately underlying beds are covered, but it assumed that they are the limestones and dolostones seen elsewhere. The formation corresponds to Brainerd and Seely's (1896) Calciferous D-3 and D-4, and in part with Cady's (1945) Bascom formation. Thickness is between 200' and 250'.

Cutting formation: Finely and medium crystalline dolostone comprises this formation. The exposures in the valley are similar to those at Shoreham. The basal unit with fine-grained, cross-bedded dolomitic sandstone at the base possesses a characteristic basal breccia of intraformational origin. Three other units are recognizable on the basis of variations in the characteristics of the dolostones and the quantity of chert. Away from the Central Champlain Valley a limestone sequence seems to take the place of some of the upper dolostones. The basal sandy unit is rather widespread, apparently. Approximately 325' thick.

Whitehall formation: Dolostone, finely to coarsely crystalline, weathers in various shades of light gray and light bluish gray and is massively bedded. In places the dolostones contain small to moderate amounts of rounded, frosted quartz grains and occasional intraformational breccias. The dolostones become lighter in color upward. Limestone is found in the formation only in one place, approximately 2 miles west of Snake Mountain.

As originally defined at Whitehall, N.Y., (Rodgers, 1937) the formation included beds that are now placed in the under lying

Ticonderoga formation (J. Rodgers, manuscript and personal communication). The formation correlates with the Shelburne limestone lying east of the thrust belt. Approximately 300' thick.

## Cambrian - Croixian

### Trempealeauian Stage

Ticonderoga formation: J. Rodgers (manuscript, personal communication) has called the dolostones and sandy dolostones lying between the Potsdam sandstone and the Whitehall formation the Ticonderoga formation and has described a type section on Mt. Hope at Ticonderoga, N.Y. The complete description of the type section is to be given in a forth-coming report on the Central Champlain Valley.

Within the area of the field trip the Ticonderoga formation consists of dark-weathering, medium to dark gray, medium and finely crystalline dolostones with interbedded coarse-and medium-grained quartz sandstones. The unit is exposed sporadically south of Vergennes to the latitude of Addison. The best exposures within the Central Champlain Valley are on the west side of Thompson Point. Nowhere is the base exposed. The formation is very similar to the dolostones at Shoreham called Clarendon Springs by Cady (1945) and Calciferous A by Brainerd and Seely (1890). Maximum exposed thickness is approximately 90' at Thompson Point. Outcrop width south of Vergennes suggests a thickness of as much as 350 to 400'.

### Dresbachian Stage

Potsdam sandstone: This formation is not exposed within the Central Champlain Valley of Vermont, but it outcrops along the Adirondack border to the west, and south of the area it outcrops on Mt. Independence and east of the Shoreham Thrust in Shoreham, along Rt. 22A. The formation is a white to pinkish weathering, generally tough massively bedded quartzite.

Bordering the area on the east as the upper plate of the Champlain Thrust is the Monkton formation consisting of two recognizable units: (1) a lower dolostone and light-colored pinkish weathering massive quartzite unit, and (2) an upper relatively thin-bedded, brick red quartzite unit. Mapping of these two units has led to the recognition of some of the cross-faults.

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ROAD LOG

## The Stratigraphy of the Central Champlain Valley

Quardrangles: Brandon 15', Middlebury 15', Ticonderoga 15'
(Bridport 7½') and Port Henry 15'.

The motorcade for Trip C will form in the parking lot of the Grand Union Market at the intersection of U. S. Routes 7 and 4 East (Woodstock Avenue). Departure time will be 8:00 A.M. Bring lunches as there are no food facilities near the lunch stop.

The first part of the trip will follow U.S. Route 7 northward to Brandon for a distance of 16 miles through areas described by Brace (1953), Fowler (1950) and Cady (1945). Road log begins in Brandon.

| Cumulative Mileage | |
|---|---|
| 0.0 | Junction of U. S. 7 and Vermont 73 from right at monument, Brandon. Brandon Inn straight ahead on U. S. 7. Follow U. S. 7. |
| 0.4 | Left turn onto Vt. 73 west (Champlain Street). Stephen A. Douglas birthplace, white house north of church on right. The first 20 miles of the trip lies in the folded belt of Cambrian and Ordovician beds of the south end of the Middlebury synclinorium which are bordered on the west and separated from the Champlain Valley sequence by "Logan's Line". While the Taconic disturbance caused intense shearing and metamorphism of the rocks east of "Logan's Line" in some places, in others the rocks are relatively unaffected by metamorphism, and they closely resemble their stratigraphic equivalents west of the main belt of thrusting. Emphasis is placed upon this statement for the rocks of the uppermost Cambrian (Clarendon Springs = Ticonderoga) and the rocks of the Beekmanton group particularly. |
| 1.4 | Road from right. |
| 1.5 | Railroad overpass. |
| 1.7 | Enter valley of Otter Creek. |
| 3.55 | Brandon-Sudbury town line. |
| 4.0 | Cross Otter Creek. |
| 6.45 | Stop sign. Junction with Vermont Route 30. Turn right. Junction is in the Hortonville formation which probably can be correlated with part of the Stony Point and the Iberville formation west of the belt of thrusting. The Hortonville represents the youngest of the Ordovician formations in the Middlebury synclinorium. |

7.3 Sudbury-Whiting town line and Rutland County-Addison County line.

8.9 Railroad crossing--prepare to make left turn.

9.2 Road junction in Whiting. Turn left. Approximate position of Orwell-Glens Falls contact with Hortonville lying to the west of the Glens Falls.

9.8 Hortonville in low outcrop in road cut on left.

10.0 Road from left; continue straight ahead on dirt road.

10.5 Abandoned railroad; Shoreham-Whiting town line. Approximate position of axial line of Middlebury synclinorium.

11.35 Road from right. Junction marks approximate position of Glens Falls-Hortonville contact on east limb of Middlebury synclinorium.

11.6 Creek. Road begins to climb. Stratigraphically the route is going down in the section. To the north approximately 1 mile Bridport (= Beldens to east) outcrops on the eastward sloping hills followed to the west (down stratigraphically) by the Bascom formation (Calciferous D of Brainerd and Seely; upper part = Cassin formation restricted) at its type locality.

11.85 Road from right follows the contact between the Bascom to the east and the Cutting to the west. On slopes of hill to the northwest is the type area of the Cutting formation (Cutting Hill). The four divisions of the Cutting that can be recognized here are recognizable in the Central Champlain Valley of Vermont and probably to the south and west in New York state also. This locality is slightly south of Brainerd and Seely's (1896) southeastern Shoreham section.

12.15 Road from left. Junction near center of Cutting. Outcrop on left.

12.3 Cemetery left. Shelburne (correlates with Whitehall formation west of thrust; basal formation of Beekmantown group) outcrop in woods to right.

12.5 Clarendon Springs dolostone (correlates with Ticonderoga formation west of thrust) in road out; fine-grained dolostone. Contact with overlaying Shelburne lies to the east ± 30 yards.

12.85 Entrance to Richville Dam Fishing Access Area.

13.1 Road from right followed by Danby (= Potsdam of New York state) in road out.

13.15 Left turn across bridge. Pinnacle Thrust which places Danby of west limb of the Middlebury synclinorium over Clarendon Springs dolostone to west lies west of the west end of bridge.

13.2 Turn right. Danby outcrop in road cut on left.

13.4 Danby in cut on left.

14.4 Clarendon Springs in hills to left and in road cut on right.

15.5 Stop sign. Junction with Route 22A. Turn right.

15.85 Junction with Route 74 from west (left) continue on Route 22A.

16.35 Junction with Route 74 right (east), continue on Route 22A. To the right is the locale of Brainerd and Seely's (1896) Shoreham section which was visited during the 1955 N.E.I.G.C. meetings. Outcrop to west of Route 22A is Clarendon Springs. Route 22A crosses thrust fault placing Orwell over the Clarendon Springs a short distance north of the quarry and gravel storage area north of the barn ahead.

17.05 Road from right. Mutton Hill to the northeast is on the lower plate of the thrust fault just crossed and is underlain by the Danby (Potsdam) through the middle part of the Bascom (Brainerd and Seely's Calciferous D-2)

17.80 Danby on right.

18.80 Bascom outcrops on slopes to left. John Rodgers (personal communication) reports Lower Canadian fossils from near the top of the Cutting formation on the hill to the west.

18.90 Halfway House and cross-roads.

19.40 Shoreham-Bridport town line. Bascom in outcrop.

21.8 Road from left; prepare to turn right.

21.9 Road from right; turn right onto dirt road.

22.25 Quarry in Iberville shale. Both cross-bedding and cleavage-bedding relations indicate that the Iberville is overturned here, "dipping" to the east.

22.40 Small Iberville outcrop on the left is right side up.

22.70 Iberville in quarry; right side up.

22.90 Iberville right side up.

23.0 Top of small rise. Glens Falls in bushes to left and hill to right. Fault contact between Glens Falls and Iberville near west base of rise. Stony Point is faulted out by what appears to be a high angle reverse fault.

23.1 Bridport dolostone (= Beldens to east) of overthrust block on right, lying on Glens Falls. Thrust fault lies in the small

valley to the west. This is the Orwell thrust of Cady, although its position is east of that shown by Cady (1945) and work to the north indicates the presence of a number of small slices on either side of it.

23.15 Junction, turn left.

23.25 Glens Falls outcrops adjacent to the road; massive dolostones capping ridge are Bridport above the Orwell thrust.

23.30 Iberville. Fault crossed between 22.90 and 23.0 miles crossed again. Continue in Iberville. The trace of the fault is about halfway up the hillside.

23.60 STOP 1 - 20 MINUTES. Please pull cars off road and forward as far as possible.
Iberville formation: Typical outcrop of this formation. Black, non-calcreous shale with thin beds and laminae of orangish-weathering, cross-laminated and very fine-grained sandstone. The outcrops here are lithologically identical with the Iberville of the islands at the northern end of Lake Champlain (Hawley, 1957). The Iberville outcrops westwart to Route 22A. Cross-bedding and cleavage-bedding relations indicate overturning. The axial line of the overturned syncline would seem to lie about 500 feet west of the road.
In general the formation is flexed into a series of small, gentle folds; however near the zone of thrust faulting some of these folds are overturned. Fragmentary pieces of graptolites have been found in a quarry approximately half a mile west-northwest from this stop.
To the east, above the quarry, the Glens Falls outcrops in fault contact with the Iberville. Higher on the slope the Orwell thrust brings the Bridport over the Glens Falls.
Above the thrust plane the Bridport is folded into an overturned isoclinal syncline with the Day Point and Crown Point formations of the Chazy group in the core of the fold.
The westward offset of the Glens Falls-Iberville contact and road junction at 23.15 miles suggests the presence of a small west-northwest trending zone of faulting.

24.05 Stop sign. Junction with Route 125. Turn right.

24.30 Road from right.

24.40 Glens Falls in road cut on left. Small outcrop of Iberville in field to west at base of hill. Reverse fault between Glens Falls and Iberville crosses Route 125 near the base of hill and is offset to the east of the fault trace on the hill to the southwest (Stop 1) of Route 125. The relationship suggests the presence of another west-northwest trending zone of faulting. Similarly the axial line of the overturned isoclinally-folded syncline in the upper thrust plate is offset to the east on the hill east of this point when compared with its position on the

hill at Stop 1.
The massive Bridport dolostones seen on the hill to the right form the lower limb of the overturned isoclinal syncline. The Glens Falls beds dip gently to the west in this and immediately succeeding exposures. Cleavage, which is easily mistaken for bedding wherever the Glens Falls is deformed, dips at an angle of ± 60° in a general easterly direction.

24.6– 24.8 Glens Falls. Fault contact between Glens Falls and Iberville crosses the hill approximately 600 feet north of the road.

24.9 Signal for left turn.

25.05 Sharp left turn onto dirt road.

25.10 Approximate position of Orwell thrust coming down slope from right.

25.20 Fault between Glens Falls and Iberville observed near Stop 1 intersects road coming from right, striking approximately north. Same fault strikes southwest as it crosses hill to left (southwest); the contact from the left intersects the road near the beginning of the dip ahead. The offsetting of the Glens Falls-Iberville contact together with structural complications in the Bridport on the hill to the northeast suggests strongly that the Orwell thrust and associated faults are cut by a zone of faulting trending approximately parallel to the road (northwest).

25.30 Enter Iberville formation.

25.45 Iberville formation in quarry. Formation is contorted and several small overturned folds appear here.

26.30 Cross-road; continue straight ahead.

26.40 Iberville in quarry.

27.20 Typical rolling knobs of Iberville covered by thin layer of lake and glacial deposits.

27.40 Stop sign. Junction with Route 22A. Approximate position of Iberville-Stony Point contact. Continue across Route 22A.

27.80 Road Junction. Turn left.

28.45 Road Junction; continue straight ahead.

28.85 Bridge across Potash Creek. Prepare to stop.

29.0 STOP 2 - 20 MINUTES. Pull cars to extreme right. Walk back to bridge and down into creek. Outcrop of Stony Point shale. Bedding dips gently (± 5°) to the east and northeast

while the cleavage dips between 35° and 45° in the same direction. Where the formation is deformed, the cleavage is the more dominant feature and may easily be mistaken for bedding.

29.25 Road junction; turn left.

29.65 Stop sign at junction with Route 22A. Turn left.

30.60 Junction with Route 125 from right; continue northward.

31.0 Signal left turn.

31.15 Turn left onto Route 125. The route for the next 7 miles crosses the flat and gently rolling floor of the Champlain Valley. Occasional outcrops to the north and south of the route suggest that the Stony Point is succeeded westward by the Glens Falls. In addition the information available indicates the presence of a belt of folding and possible faulting succeeded westward by a virtually undeformed zone with prevailing westerly and northwesterly low angle dip (± 5°). It is likely that these two zones are truncated to the north, in the latitiude of the north end of Snake Mountain, by an east-west trending zone of rupture.

38.10 Prepare to turn right.

38.30 Turn right (north) for junction with Route 17.

38.70 Cross Hospital Creek. Small quarry on right contains sandy limestones of the Valcour formation (Upper Chazy).

38.80 Prepare to turn left.

38.90 Turn left into driveway and continue to shore.
STOP 3 - 1-1/4 HOURS. A total thickness of 315 feet of fossiliferous Glens Falls limestones outcrops along the shore on the south side of Crane Point. In the pasture to the southeast Orwell (Isle la Motte) outcrops beneath the Glens Falls with the Larrabee member of the Glens Falls overlying it. All of the outcrops along the shore belong to the Shoreham member. Near the northwest corner of the farm house and southwest of the barn are outcrops of the sandy and dolomitic Valcour. However, the best exposure of this formation is in the small quarry near Hospital Creek.
The complete Chazy sequence (Day Point, Crown Point, Valcour) is present on Crown Point across the lake.

38.9 Turn cars around and return to driveway and milage 38.9

39.6 Turn left at Route 17.

40.4 Road junction. Leave Route 17 and continue northward on the dirt road to the left (west) of the store.

40.9 STOP 4 -30 MINUTES. Owls Head Harbor turn left and drive to end of road. Walk down to beach. Outcrops along shore on south side of cabins represent the upper part of the Glens Falls formation. Northward the limestones become more argillaceous and are eventually replaced by shale of the Stony Point about 1000 feet north of the last cabin. These upper shaly limestone beds represent the transition from the Glens Falls to the overlying Stony Point. The transition beds are recognizable over a wide area in the Central Champlain Valley, and probably they correlate with the Cumberland Head formation of the northern part of the Lake Champlain region. In the central Champlain Valley they have been mapped with the Glens Falls since it is almost impossible to separate them from the Glens Falls in areas of poor exposures and extreme deformation. They can usually be differentiated from the Stony Point shale because of the presence of fragments of "Glens Falls fossils," especially Cryptolithus tesselatus Green, and because of the association with them of fragments of argillaceous limestones of the Glens Falls type.

40.9 Return to road junction at 40.9 miles and turn left (north).

42.50 Slow.

42.60 Stony Point outcrops along lake shore.

42.80 Stony Point in small quarry to right and road cut to left.

43.05 Road junction; continue straight ahead.

46.6 Bear right on paved road.

47.0 STOP 5 - 25 MINUTES. Walk south along ridge approximately 1/4 mile. At this stop the uppermost beds of the Day Point and the lower beds of the Crown Point formations are exposed. The contact is gradational and seems best placed at the crest of the west-facing escarpment. A few boulders of very pale yellowish brown dolomitic siltstones and silty dolostones typical of the Day Point can be found, although these beds are covered by talus from the limestones. The Day Point-Crown Point beds contact is placed where the limestones change from 4-6" thick beds with very few black or buff silty partings to 3-4" beds with such partings as a common feature. Also the bluish-gray coloration of the limestones seems to change slightly, the upper beds seeming to be more bluish-tinted. The ridge to the west is Bridport dolostone.

47.4 Valcour outcrop in road cut on left.

47.45 Road junction; turn left.

48.05 Panton Four-corners, continue north.

48.10 Orwell outcrops on left side road and on hill to right.

48.50 Road junction; bear right.

48.60 Orwell to left in dip slopes.

49.50 STOP 6 -35 MINUTES. Walk westward across pasture. Outcrops adjacent to road are Glens Falls. These are succeeded westward by typical Orwell, massive, black, fossiliferous limestones. At this locality the upper part of the Valcour closely resembles the Orwell, and the contact is placed only with great difficulty. Farther south, the Valcour contains much quartz sand, and lenses of cross-bedded quartz sandstone are present, the exposures resembling those in the Crown Point area. The contact between the Valcour and the underlying Crown Point is placed near the top of the west-facing escarpment where the bluish gray, sublithographic and fine-grained fossil-fragmental limestones give way to coarse and medium grained, very light gray to almost white fossil fragmental limestones. The Valcour is approximately 50 feet thick at this stop, but it expands rapidly to more than 150 feet south of Panton.
While fossils are difficult to extract from the limestones here, some good specimens may be obtained.

50.35 Road from left, continue straight ahead.

51.25 Road junction. Turn right toward Vergennes. The route now follows Otter creek to Vergennes where MacDonough built his fleet during the War of 1812.

53.9 Road junction and stop sign. Turn left.

55.25 Stop sign; junction with Route 22A. Turn left.

55.4 Signal for left turn.

55.5 Turn left on Canal Street between the two wooden buildings.
STOP 7 - 15 MINUTES. Whitehall (= Shelburne east of thrust belt) lies on Stony Point shale. As exposed in the ditch north of the road the fault plane seems to have a high angle of dip, and it may be dipping to the west. Away from the fault the Whitehall dips gently eastward; the Stony Point here and in exposures north of Otter Creek. The fault displayed here continues southward to the latitude of Addison where it either dies out or is offset by a zone of rupture with strikes in a general east-west direction.
Turn cars around and return to intersection of Canal Street and Route 22A and mileage 55.5.

55.5 Canal Street and Route 22A. Turn right on Route 22A.

55.8 Whitehall formation in road cut on right. Basal Cutting breccia exposed in driveway of barn on left. Prepare to turn left.

55.9 Turn left onto dirt road (Hopkins Road).

56.05 STOP 8 - 25 MINUTES. Climb hill behind oil tanks for exposure of breccia at base of Whitehall formation. This breccia and the basal unit of the Whitehall are better exposed at Thompson Point

about 7 miles north and west of Vergennes. After viewing breccia walk eastward across road to visit the top of the basal unit of the Cutting exposed in the west face of the ridge and the two succeeding units of the Cutting. The fourth unit is not exposed here, but four are recognizable at Thompson Point as well as on Cutting Hill in Shoreham (see mile 11.85).

56.35 Quarry. Ticonderoga formation (= Clarendon Springs) with Whitehall overlying it at the top of the quarry face. One or more small cross-faults cause the exposure of the Ticonderoga here. For the most part it is exposed along the west-facing escarpment of the ridge west of the quarry.

56.60 STOP 9 - 15 MINUTES. Walk across ridge to west of road to view the Whitehall formation and the upper part of the Ticonderoga formation. Ticonderoga exposures along Route 22A display sandy dolostone and medium-grained sandstones.

58.1 Road junction; turn left.

58.4 Hill to left is part of the basal unit of the Cutting. South of the low tree-covered ridge to right are limestones lithologically similar to limestones in the upper part of the Cassin formation and containing similar fossils.

59.7 View of the north end of Snake Mountain. The Champlain Thrust crosses at the base of the steep slope approximately one-quarter of the way down from the top. The three knobs on the east slope are capped by Monkton quartzite and dolostone and are offset along small cross-faults which apparently post-date the development of the Champlain Thrust. Beneath the main thrust there are several small thrust faults which bring Crown Point and Bridport beds over the younger Stony Point shale. These thrusts are also cut by the cross-faults. About in the middle of the west face of Snake Mountain there is a band of non-calcareous shale surrounded by calareous shale. The present interpretation is that it represents a lens in the Stony Point, isoclinally folded, overturned syncline beneath the thrust.

61.8 Outcrop of Stony Point in pit on left.

61.95 Junction with Route 17. Turn left after stop.

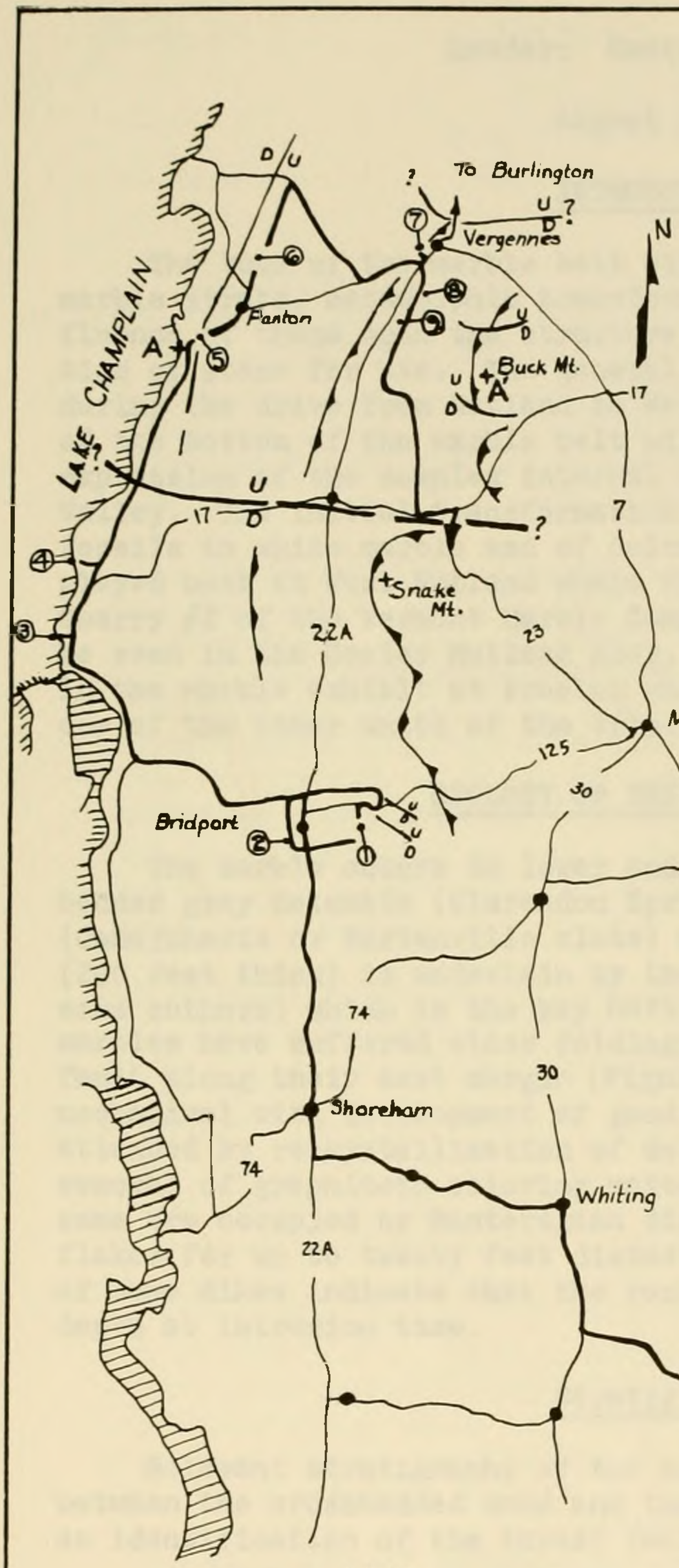
62.3 Slow to observe thrust.

62.4 Thrust fault beneath main Champlain Thrust. Bridport on Stony Point. This is one of the thrusts beneath the main Champlain Thrust, which is exposed on the knob south-southeast of this spot (lowest of the 3 knobs mentioned at mile 59.7) and near the top of the hill almost due east across Otter Creek. The southward continuation of this fault lies beneath the cover of the slopes to the south of the road and seemingly at a lower elevation than the exposure north of Route 17. The relationships here and on a regional scale suggest the presence of an east-west

trending zone of rupture.

62.7 Junction with Route 23. End of log.

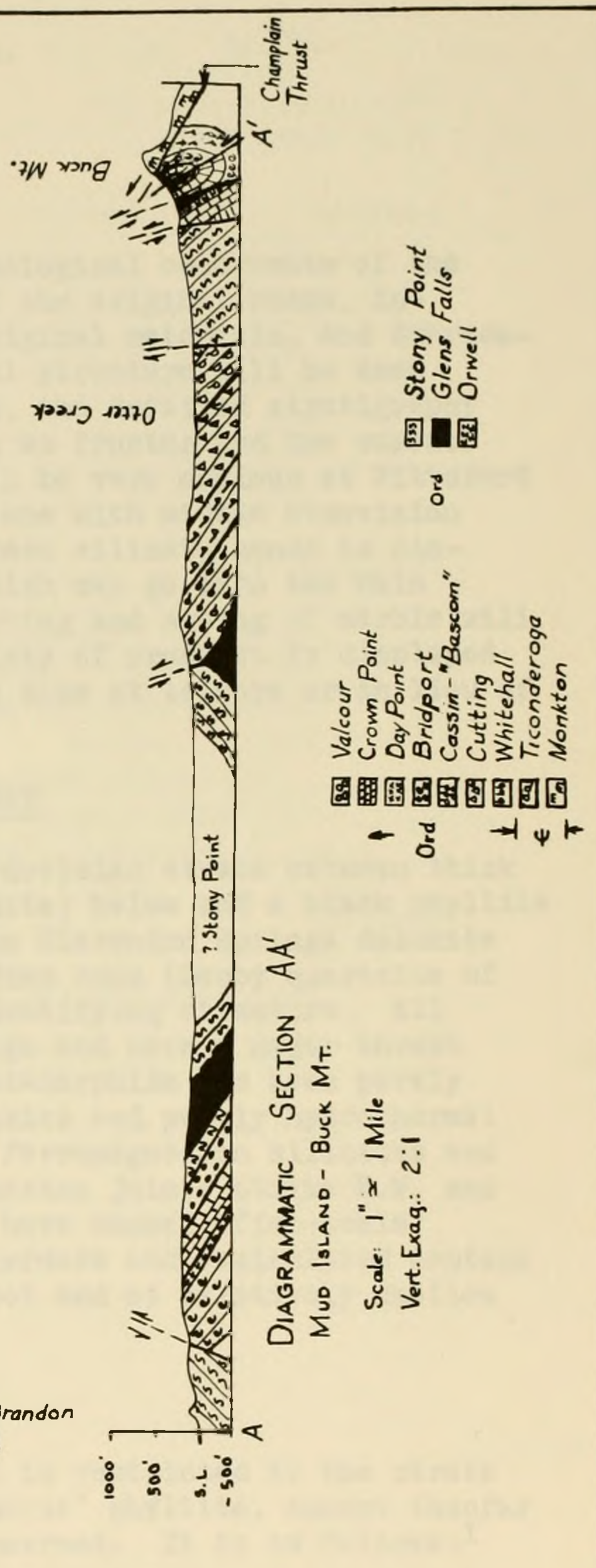
Route 7 to Rutland may be reached by following Route 23 to Middlebury or by continuing on Route 17 to New Haven Junction. It will take approximately an hour to reach Rutland from this point.




ROUTE MAP SHOWING FAULTING

Trip C
High Angle Fault
Thrust
Stop
73 Route No.

0 2 4
Miles




DIAGRAMMATIC SECTION A-A'
MUD ISLAND - BUCK MT.

Scale: 1" = 1 Mile
Vert. Exag.: 2:1

# PLATE 1 - TRIP C

N.E.I.G.C. MEETING, RUTLAND, VT.
OCT. 17-18, 1959

C.W. Welby 7/1/59